DOCUMENT RESUME

ED 267 575 EC 182 096

AUTHOR Hedbring, Charles
TITLE Computers and Autistic Learners: An Evolving Technology.
PUB DATE 85
NOTE 28p.
AVAILABLE FROM Hedbring and Associates, Suite 1712 Master Apts., 310 Riverside Dr., New York, NY 10025 ($7.95, $5.95 for 10 or more).
PUB TYPE Journal Articles (080) -- Reports - Descriptive (141)
JOURNAL CIT Australian Journal of Human Communication Disorders; v13 n2 p169-94 Dec 1985

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Autism; *Communication Aids (for Disabled); *Computers; Computer Software; Demonstration Programs; Program Development; *Severe Disabilities

ABSTRACT

A research and demonstration computer center for severely handicapped autistic children, STEPPE-Lab, which uses computers as an augmentative communication and instructional system, is described. The article first reviews the keyboard, joystick, mouse, and drawing tablet as augmentative devices for helping communication disordered children interact more meaningfully with their environment. Noted is the lack of empirical software appropriate for this population. The software packages developed by STEPPE are discussed with information on curriculum areas and perceptual motor skills emphasized. Also considered are the logic and requirements for evaluating the content validity of commercial software from an empirical perspective. Guidelines are offered for marshalling political support for computer demonstration centers. Five long-term goals for the project are identified, including issues of overselective responding and generalization. (CL)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED267575

COMPUTERS AND AUTISTIC LEARNERS: AN EVOLVING TECHNOLOGY

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Charles Hedbring

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Charles Hedbring, Director
Program STEPPE, New York City

The purpose of this article is to describe a research and demonstration computer center for severely handicapped, autistic children located in a public school in New York City. Called STEPPE-Lab, the model classroom uses computers as an augmentative communication and instructional system. The article first reviews the keyboard, joystick, mouse, and drawing tablet as augmentative devices for helping communication-handicapped children interact more meaningfully with their environment. The article then discusses the lack of empirical software appropriate for this population, describes the software packages Program STEPPE has thus developed, notes the perceptual-motor skills the software emphasizes and the curriculum areas the programs embrace, sets forth the logic and requirements for evaluating the content validity of commercial software from an empirical perspective, and offers a set of guidelines for marshalling political support for computer demonstration centers. The article concludes by suggesting several research areas fertile for further investigation of the instructional role computers can play on behalf of severely handicapped, autistic learners.

For most applied researchers, autism remains something of a mystery syndrome. The diagnostic signals seem vague, assessment techniques continue impure, and modes of intervention often prove disappointing. The result has been a multiplicity of descriptions that have stretched Kanner's (1943, 1944) original definitions to a point where current classification schemes present a formidable obstacle to the development of more refined assessment and intervention protocols. Yet, amid the tumult there is little doubt that autistic children exhibit a constellation of learning handicaps and that perhaps nowhere are those impairments more apparent than in the area of communication. Accordingly, the purpose of this discussion is first, to review briefly the state of microcomputer technology as it benefits the severely handicapped and second, to describe in some detail a computer laboratory located in a New York City public school that addresses the communication disorders exhibited by more than forty severely handicapped, autistic pupils.

COMMUNICATION AND COMPUTERS

In light of their many handicaps, autistic children struggle to learn. For the teacher and psychologist, it becomes all too clear during initial encounters that the struggle focuses on a persistent inability of the autistic child to communicate effectively. The communication disorders are of such magnitude that, in general, such children have little option but to pull, tug, whine, cry, or tantrum to express and convey their needs. Research has found that communication disorders associated with autism range from a total absence of speech to minor problems in articulation, from elective mutism to persistent echolalia (Fay, 1969; Rutter, 1968, 1978b). Caretakers and service providers discover that autistic children

EC182096

characteristically are late in beginning to speak and that nearly half remain mute throughout their lives (Rutter, 1966; Wing, 1976). Teachers in turn learn early on that autistic pupils fortunate enough to possess some measure of speech may still lack spontaneous sentence formation (Newsom & Rincover, 1981). They find that many autistic learners are "unable to follow even simple commands unless accompanied by gestures" (Russo & Newsom, 1982, p. 133) and that the scope of their communication disability is markedly "more severe and more deviant" than children classified as language-impaired (e.g., Ornitz & Ritvo, 1976).

In light of these compromised communication abilities, speech and language interventions have focused to a large extent on a variety of augmentative communication systems. Some of the more notable systems include Blissymbolics (Bliss, 1965), non-speech language initiation programs (Carrier, 1974, 1976; Carrier & Peak, 1975), communication boards (e.g., Harris & Vanderheiden, 1980; Vanderheiden & Harris-Vanderheiden, 1976), finger spelling regimes (Moores, 1974; Quigley, 1969) and sign language training (e.g., Carr, 1979, 1982). The use of these and other approaches for augmenting the communication abilities of severely handicapped children is important for three reasons. First, the systems present a number of options and opportunities for helping nonverbal children communicate more effectively. Second, the options derive from a line of research that has clarified at least some of the factors instrumental in the process of acquiring language. And third, the research with autistic children in particular is noteworthy because it parallels and extends the work of a number of investigators who have been successful in the use of augmentative communication strategies with severely and profoundly retarded children (e.g., Deich & Hodges, 1982; Duker & Michielsen, 1983; Duker & Morsink, 1984; Kohl, 1981).

At the same time, however, and from a practical point of view, augmentative communication approaches have limited utility in public school settings. To begin with, it is estimated that more than 50 percent of the autistic population have IQs below 50 (Chess, 1971) and that some two-thirds of all such children can be expected to "perform throughout life at retarded levels" (Ornitz & Ritvo, 1976, p. 613). Prognosis for improving communication deficits on that basis alone cannot be considered good, particularly in light of Rutter's (1978a) finding that "the IQ score in autistic youngsters (has) proved to be a reasonable predictor of later educational attainment" (p. 5). Second, many of the augmentative aids currently in use "require a wide range of motion and fine motor skills" (Harris & Vanderheiden, 1980, p. 295) which autistic children often do not possess (Curcio, 1978; Jones & Prior, 1985). Augmentative aids of the kind noted above also depend upon symbolic gestures and imitation repertoires which, again, many autistic children lack (Ricks & Wing, 1976; Rutter, 1978a). Accordingly, while it may be possible to teach some children a small number of signs, there is concern that, on balance, few autistic children will benefit from such training (Goetz, Schuler & Sailor, 1979). As a case in point, Carr, Binkoff, Kologinsky, and Eddy (1978) used a communication training program with four autistic children that included words (auditory stimuli) and signs (visual stimuli) presented simultaneously. Analysis of their data revealed that the children learned the signs on the basis of the visual rather than the auditory cues. As Duker and Morsink (1984) noted, there is reason to believe, therefore, that the number of signs autistic children might learn under this approach would be limited to a rather small class of stimuli. Third, results to date suggest that many autistic learners may not be

able to retain the subtle discriminations necessary to use simultaneous communication (presentation of word and sign/gesture together) on a long-term basis and further, that the learning of new signs might largely be a function of the dimensional properties of the signs themselves (Kohl, 1981; Newsom & Rincover, 1981; Ricks & Wing, 1976). Fourth, many autistic students require uncommonly high levels of training trials conducted over a period of years to acquire functional speech (Goetz et al., 1979); others fail to acquire speech regardless of the number of training trials, due in part to attentional deficits (e.g., Carr, 1979); and for still others, the limited outcomes of intense training tend not to generalize beyond the treatment setting (Harris, 1975). As Goetz et al. (1979) conclude, "the issue of manual signing as a facilitator of speech acquisition is much more complex than previously assumed" (p. 339). Taken together and following the advice of Etzel and LeBlanc (1979), the evidence accumulated over the past several years suggests a need to search for a more parsimonious alternative to addressing the communication handicaps of severely handicapped, autistic children.

COMMUNICATION AIDS: Severely Handicapped

One alternative that holds particular promise for children with severe communication disorders is the application of microcomputer technology. The birth of the silicone microchip (Boraiko, 1982; Davis, 1983) and the resulting Lilliputian-size computers have brought this technology within reach of increasing numbers of special education children along with their teachers, administrators, and school budgets. In the United States alone, even the more conservative estimates forecast growth rates for personal computer sales to be in the neighbourhood of 10 to 20 percent annually (Axelrod, 1985; *Business Week*, 1985). Moreover, in a major U.S. survey of the instructional uses of computers, the Corporation for Public Broadcasting (1985) found that about 75 percent of the schools owned computers (in 1983) and more than 80 percent of the 2.1 million teachers surveyed believe computers can improve teaching. Regarding the special education market, in 1983 (the latest year such figures are available) some 60,000 microcomputers were in use in special education, with roughly 75 percent of them devoted to instructional purposes. By the end of 1985, it is projected that nearly 150,000 computers will be used primarily for special education (Blaschke, 1985).

These trends in the growth and use of microcomputers in special education have led to the rapid development of a variety of highly sophisticated augmentative aids. These aids offer new hope for communication-handicapped children, including those with vision and hearing impairments. For example, the *blind* are now aided by talking terminals (e.g. PC Orator), speech synthesizers (e.g., Kurzweill Reaching Machine; Votrax Personal Speech System) and text-to-speech converters (e.g., Votrax Type-'N-Talk). For those with impaired vision there are large-print displays (e.g., Arts Computer Products), some of which can magnify letters on computer screens up to 16 times their normal size (e.g., Visualtek Corp.). Moreover, special Braille printers (e.g., Versa Braille) can now use word processing programs to produce Braille text. For the *deaf*, the Video Voice Speech Training System (Micro Video Co.) translates words and sounds

into visual patterns as they are spoken into a microphone. By comparing the visual "templates" of correctly enunciated sounds, the hearing-impaired child can learn to shape his or her uttered sounds to bestfit the "correct" sound patterns that appear on the computer screen.

Communication-handicapped individuals with severe *physical* impairments (cerebral palsied, quadraplegics, amputees, stroke patients), have also benefitted from the striking advances in this hardware technology (Bates, 1985; Rushakoff & Lombardino, 1983). There are, for example, "sip and puff" switches operated by breath control alone; voice input modules that allow computer operation through clicking sounds made with the tongue; special keys (e.g., Zygo Industries) and keyguards (e.g., Prentke Romich Co.) to facilitate keyboard entry. Also available are "lever switches" (that utilize head motion), "leaf switches" (that rely on simple elbow movement), and "brow-wrinkle" switches (attached to the head by a special band) — all of which can be used by the physically handicapped to operate computers. Moreover, there is now a communication device that is based soley on direct eye contact. Called Eyetyper (Sentient Systems Tech Co.), the device that is activated when the user glances at a key on the computer keyboard. A tiny light then brightens, beeps, and the character associated with that key is displayed on a two-row bar at the bottom of the keyboard. Finally, the teacher, researcher, and administrator have also gained from this computer-driven revolution. The technology offers them such text-entry devices as the Omni-Reader (Oberon Co.) that allow the printed word to be electronically read and stored on disk (see *InfoWorld*, 1985 for a product evaluation). The potential impact of this technological gadget alone on instructional management, research, and publishing agendas is both obvious and welcomed.

This brief review of some of the alternative and augmentative communication products available to the handicapped only samples the ever-improving hardware technology. Yet, it does underscore the growing impact of microcomputers on special education in general and on communication handicaps in particular. Indeed, one recent survey in the United States found that nearly 80 percent of the producers and publishers of special education software provide the opportunity for at least one of their packages to be interfaced with communication devices (Blaschke, 1985). As Bates (1985) reports in his survery of this startling technology, "if you can twitch a muscle, you can probably use a computer" (p. 124). (For a comprehensive reference guide that includes more than 60 pages of special education hardware and software producers, the interested reader is referred to Hagen (1984) and Linc Associates, Appendix I.)

COMMUNICATION AIDS: Autistic Learners

Not long ago, Harris and Vanderheiden (1980) commented that "one of the first problems encountered in developing an effective communication system for nonvocal, severely physically handicapped persons is establishing an effective mechanism through which the individual can interact, respond, and express himself" (p. 261). A number of those mechanisms have been outlined above. In similar fashion, the practitioner striving to help the autistic child communicate

with an outside world will likewise be faced with the challenge of identifying an effective vehicle for ensuring meaningful self-expression. With the recent advances being realized in microcomputer technology, a number of computer hardware devices offer great promise as augmentative communication aids for all severely handicapped children, especially those diagnosed as autistic.

Turning to these augmentative aids, the computer keyboard represents perhaps the best known communication device. The nonverbal child simply enters letters, words, icons or other symbols through a keyboard and messages appear on the computer screen. Lately, some keyboards (e.g., Keytronic Co.) have become available that can be adapted to meet individual needs of users who may experience problems with fine motor coordination. However, for the child unfamiliar with the alphabet, or who may have trouble with the "hunt-and-peck" routine of finding and pressing correct keys, several alternative communication devices are available. Some of the more prominent options that can be attached to a microcomputer and used in conjunction with a TV-like monitor include: (1) Electronic "mouse" — a small, hand-held communication device that has a sensor in the bottom to detect motion over a flat surface. As the device is moved along a desk, the motion directs a cursor on the screen. The mouse is excellent for selecting and manipulating communication symbols, that is, for moving, letters, words and so forth around the screen. The gadget is also valuable as a communication aid because it can be used on practically any surface, fits comfortably in the hand, and is essentially nondestructable. The main drawback is that the mouse is not well suited for modes of self-expression that involve free-hand drawings. (2) Drawing tablet — a notebook-size pad that, unlike the mouse, offers the nonverbal child an opportunity to communicate through the use of a finger or special pen ("stylus"). Rather than interacting with the outside world by means of keyboard entry or "mechanical rodent," the child expresses need by sketching or tracing words or coded symbols on a sturdy pad positioned nearby. (3) Joystick — another of the remote communication aids and one that consists of a freely moving vertical lever fixed to a base, that controls a cursor or icon on the computer screen. By moving the lever, the nonverbal user manipulates letters, numbers and other symbols on, off and around the screen in order to communicate with others. (4) Light pen — an augmentative communication device that allows the nonverbal user to interact by marking on any hard surface with a special pen. The signals are then transferred to the computer and, depending upon the software, words, sentences, icons or other symbol systems can be manipulated on the screen. The main advantage of the light pen as a communication device is that the user is not encumbered by keystrokes or possibly bulky drawing tablets. As long as the user has the prerequisite fine motor skills, practically any surface can act as a communication medium. (5) Touch screen — allows the user to communicate nonvocally by touching a clear screen overlay that is sensitive to pressure. By applying pressure to the computer screen with a finger, an icon or other symbol at that location initiates a preprogrammed series of phrases, sentences, or drawings. The main advantages of this device are that (a) no hardware peripherals need be mastered by the user and (b) the natural urge on the part of the nonverbal child to point to what is desired is utilized. Perhaps the main disadvantages of the touch screen are that (a) the unnatural position of the arm and hand required to operate the device can result in early onset of fatigue, and (b) being so close to the video display for prolonged periods may create eyestrain and, some say, possible problems with screen radiation.

Clearly then, the hardware is available for offering the nonverbal child a host of options for using the computer as an augmentative communication system. Through product reviews carried in major computer periodicals, new and more powerful software packages required to use these devices are being made available to innovative professionals almost on a weekly basis (See Appendix II). In addition to and quite apart from promoting self-expression, however, these augmentative devices also provide a great deal of daily practice in a number of perceptual-motor areas important to independent functioning. For example, the devices provide training in skills such as fine motor dexterity and eye-hand coordination (using the mouse or joystick), figure-ground differentiation (manipulating the mouse-driven cursor on the computer screen), and visual tracking (pressing and holding down the correct button on the mouse in order to produce a brightly colored line which the child then uses to follow the teacher's finger across the screen). Moreover, the devices provide practice in number recall and letter recognition (through use of the computer keyboard) as well as attention training and discrimination (reinforced use of the various hardware mechanisms). In sum, the incidental gains alone that communication-impaired children can reap from the use of augmentative computer devices may soon reach enormous proportions as the technology continues to make an intentional impact on instructional practice.

COMPUTERS FOR COMMUNICATION: Empirical Courseware

That advances have been realized in computers which make the technology eminently valuable to special education is clear. Indeed, the *hardware* has existed for some time (Colby, 1973; Panyan, 1984; Taber, 1981; Thomas, 1982), though underutilized until recently due to the primitive state of augmentative communication technology. The challenge now facing the innovative practitioner planning to use computers as a communication system is thus not a lack of hardware. Rather, the pressing challenge is to locate *software* that is clearly *appropriate* for severely handicapped, autistic children.

Within the context of software development, "appropriate" is defined in terms of *content validity;* that is, to what extent does a software package reflect the domain it purports to represent? This paper contends that a major obstacle slowing the advance of computer-aided instructional technology is the continuing lack of *software* appropriate for autistic and other severely handicapped children with learning problems. We know, for example, that quite apart from their acknowledged communication problems, many autistic children exhibit severe deficits in attention (cf. Butler & Rabinowitz, 1981; Cook, Anderson & Rincover, 1982; Gersten, 1980; Lovaas & Koegel, 1973; Lovaas, Young & Newsom, 1978; Ross, 1976; Schreibman & Lovaas, 1973; Zeaman & House, 1979). These attention deficits are often manifested in a variety of off-task behaviors, including hyperactivity, distractibility, noncompliance, aggressiveness, and self-abuse. It is the severity of such deficits that has led to the development of instructional guidelines and specially designed curricula useful for training attending behavior (e.g., Krupski, 1980; Lovaas, 1981; Rincover & Koegel, 1977; Rincover, Koegel & Russo, 1978; Rutter, 1970; Schreibman &

Koegel, 1982; Scott, 1966; Stevenson, 1972; Trabasso, 1968; Wing, 1976).

Instructional software designed for children with severe language and communication impairments should make every effort to faithfully and accurately reflect the *empirical* research on the learning characteristics of the severely handicapped. The literature is considerable and persuasive in this regard (e.g., Bijou, 1972; Dunlap & Koegel, 1980; Hedbring & Newsom, 1985; Koegel & Egel, 1979; Koegel, Egel & Dunlap, 1980; Lovaas, 1977; Lovaas & Newsom, 1976; Newsom, Carr & Lovaas, 1979; Rincover, Koegel & Russo, 1978; Varni, Lovaas, Koegel & Everett, 1979). Moreover, in order to further ensure the content validity of software developed for this population, computer courseware should mirror the major findings in the area of nonverbal instruction as well (e.g., Guess, 1980; Guess, Sailor & Baer, 1976; Kent, 1974; Sailor et al., 1980). While the reader is referred to Hedbring (1985a) for a more thorough discussion of this issue, it is argued that instructional software or "courseware" which strives to achieve even a minimum level of content validity should incorporate at least the following seven *instructional rules*: (1) "reinforcer variation" (e.g., Ayllon & Azrin, 1968; Egel, 1981). Empirical courseware should incorporate the concept of a "reinforcement menu," in order to reduce the likelihood that the learner will otherwise satiate on the limited types of rewards available. Thus, each software offering should include several distinctly different graphic displays that the computer program calls up one at a time, either sequentially or randomly with each correct user response; (2) sensory reinforcement (e.g., Ferrari & Harris, 1981; Gutierrez-Griep, 1984; Rincover et al., 1978). Empirical courseware should include such proven reinforcing stimuli as music, variable tone intensity, visual-graphic images, and even computer animation — all of which influence distractible learners to remain on-task for longer periods of time; (3) rotated instructional tasks (Carr et al., 1978; Egel, 1980). Empirical courseware should provide on-line "supervisory menus" that allow the instructor to select from a number of tasks and activities within a given curriculum area. Rotated instructional tasks reduce fatigue and increase on-task attention; (4) contiguous response-consequence relationships (e.g., Dunlap & Egel, 1982; Williams, Koegel & Egel, 1981). Empirical courseware should stress graphics-based, sensory-rich rewards that immediately accompany every instance of correct responding. At the same time, the software should include one "negative graphic" (perhaps a "sad face," with animated tears and accompanying "Sorry, try again . . .") that is invoked upon each and every error-response; (5) error-correction and prompting procedures (Falvey et al., 1980; Grimes, 1981; Koegel, Russo & Rincover, 1977). Empirical courseware should include "starter cues" that branch the learning sequence so that the autistic learner is provided with built-in assistance when repeated errors occur. Software-embedded instructional prompts can take the form of strategic highlighting, underlining, bright-color coding, flashing symbols, and the like (e.g., Meador, 1984; Meador, Rumbaugh, Tribble & Thompson, 1984). Software should also include provisions to fade-out the prompts gradually and systematically so that the pupil will be able to successfully bridge the perceptual "gap" between training prompt and teaching stimulus (Dunlap & Koegel, 1980; Hedbring & Newsom, 1985); (6) initial one-modality sensory emphasis. Applied research suggests that autistic children tend to favor "proximal receptor" tasks — that is, activities that involve touch rather than sight (Frith & Hermelin, 1969; Gibson, 1969; Hermelin & Frith, 1971; Hermelin & O'Connor, 1967; Ornitz & Ritvo, 1976). Empirical courseware should thus

emphasize at the outset of instruction either the visual or tactile modality. As the on-task attention of the learner becomes more assured, the software package may progressively introduce additional modalities through the use of paired-association and "stimulus shift" activities; (7) repeated practice (Hedbring & Newsom, 1985; Mulligan, Lacy & Guess, 1982; Schover & Newsom, 1976). The research is now convincing that practice indeed improves performance and that additional practice ("overtraining") can produce a "learning to learn" effect. Empirical courseware should thus provide opportunities for overtraining, that is, for repeated and distributed practice. Through programmed subroutines that branch the user to "stepped-down" levels of instruction, ample practice at the proper level of difficulty is possible in cases of repeated pupil error. In sum, these seven instructional rules establish an empirical baseline for special education software. That so little *empirical* courseware exists continues to undermine a technology just now beginning to emerge.

Admittedly, empirically valid software demands painstaking research. Moreover, it is exceedingly difficult to write, expensive to test, and even more costly to market. When a buying public is comparatively small, as is the case when developing computer software for severely handicapped learners within the special education market, such factors become even more important. Probably as a result, commercial software tends toward "bells and whistles" — focusing more on entertainment value rather than on instructional content. One reason for this misplaced precision may lie in the video-game mentality that substitutes fun and dazzle for learning. The logic that underpins such formats is that animated graphics have succeeded in luring kids to storefront video arcades; thus, students can similarly "be motivated to expend the same energy on educational concepts disguised as arcade games" (Burns, 1985, p. 140). Reasoning of this sort may apply to some groups of youngsters, but researchers and practitioners alike understand that autistic pupils (and many other learning-handicapped children) require, by definition, specially designed curricula that simply do not fit the video-arcade mold. Flooding a computer screen with a montage of visual and auditory stimuli that are quite irrelevant to the content and goal of an instructional frame is highly distracting to autistic children beset by attentional and perceptual handicaps (Hedbring, 1985b). Nonetheless, software publishers appear convinced that an excess of "Pacman"-like animation will offset poor curriculum design, absence of empirical validity, and lack of handicap-specific instructional content that characterizes so much of the educational packages currently available.

Another reason for the inappropriate nature of much of the software available to the special education market may have something to do with the personnel involved in developing and producing educational software. It seems safe to say that software producers tend to staff their workrooms with programmers, graphics experts and, lately, with documentation writers. Yet, from the evidence to date, it is equally apparent that nowhere is a curriculum developer, special education consultant or child development expert to be found. While such a policy may now be changing, too many courseware products on the educational shelves continue to ignore the importance of tailoring software to the individual characteristics and learning curves of severely handicapped children. The market is there; absent, however, is a cadre of instructional design experts knowledgeable in the atypical developmental patterns of handicapped learners. Whatever the reasons for the stagnant state of special education software, Burns (1985)

summed it up in a recent column when he asked, "Who's responsible for the sorry state of educational software?" (p. 140; see also *Business Week*, 1984). Clearly, when it comes to commercial software for severely handicapped, autistic learners, content validity too often proves secondary to entertainment validity. That educators continue to buy empirically vapid software only serves to assure a continued stream of inappropriate software that may one day flood our classrooms.

COMPUTERS FOR COMMUNICATION: Program *STEPPE*

The hardware technology is available to expand greatly the opportunities for autistic, severely handicapped learners to communicate beyond the limits imposed by communication boards and sign language. Courtesy of touch screens, mice, joysticks, drawing tablets and adaptive keyboards, the computer represents a new and exciting medium for communicating more efficiently and in a far more understandable manner. The dark side of this new reality, however, continues to be a troubling lack of empirically valid software. Amid cautious optimism, then, a computer demonstration center was established during 1984 in a public school for severely handicapped, autistic students located in New York City.

The original intent of "STEPPE-Lab," as it has come to be known, was to extend a set of findings generated by an earlier research study funded by the United States Department of Education (Hedbring, 1981). (Parenthetically, *STEPPE* is an acronym for Systems for Total Educational Planning, Performance, and Evaluation.) The federal grant had investigated alternative approaches to teaching autistic children who, in addition to their communication problems, exhibit severe deficits in attention and discrimination skills. The major finding of the Hedbring study was that overtraining on a four-step stimulus shift program involving graded stimuli can help attention-deficit autistic children bridge the perceptual leap from object perception to pattern perception, particularly when compared to Piagetian-based perceptual-motor activities alone (Hedbring & Newsom, 1985). If followup replication efforts confirm that it is indeed possible to engineer on-task attention, decrease overselectivity and thus improve discrimination learning as the study suggests, then perhaps some portion of the research methodology and empirical foundation could be applied to the study and amelioration of communication problems as well.

The implications of the study thus invited further investigation and seemed particularly well-suited to the use of microcomputers. Hence, the laboratory was proposed and initially consisted of one IBM-compatible computer called the Mindset. Now on permanent display in the Museum of Modern Art in New York City, the Mindset is a true 16-bit computer, offers dual-floppy 360K drives or a 10-megabyte hard disk option, provides unparalleled high-resolution graphics (640 x 400 pixels), 16 colors (through GW-Basic) and includes sufficient internal memory (256K RAM) to run all IBM software (administrative as well as instructional) useful to the project. (The interested reader is referred to the April, 1984 issue of *Popular Computing* and the June, 1985 issue of *Byte* for reviews of the Mindset computer.) In addition to the computer itself, the STEPPE laboratory was also equipped with a joystick, electronic mouse, and drawing

tablet, along with three software packages. Subsequently, this author wrote a grant which resulted in the New York City Board of Education providing the center with the following additional equipment: five Apple IIe computers, each with 64K RAM, five color monitors, six disk drives, one hard disk, a networking system, one letter-quality printer, and a raft of software that is still undergoing in-class evaluation.

STEPPE-Lab: Instructional Setting

The STEPPE laboratory is located in an adolescent autistic unit that consists of 41 clinically defined autistic pupils with the following characteristics: Seventy percent (29) are male, and 55 percent (22) are of minority background; the CA range is 11 to 20, with nearly 80 percent less than 18 years old; the IQ scores range from 25 to 64 (with 33 percent untestable). Approximately 35 percent of the children live in group homes. Of immediate concern to the project was the fact that at least eleven pupils are considered hyperactive, four more are self-abusive, and another five sufficiently aggressive to pose a risk to themselves and their environment; about 20 percent of the children are on prescriptive medication.

In terms of instructional setting, STEPPE-Lab tries to ensure maximum use of available instruction time. In this regard, some years ago Lindsley (1964) stated rather emphatically that "children are not retarded. Only their behavior in average environments is sometimes retarded" (p. 62). Embracing the spirit of that assertion as a working hypothesis, instruction in the model classroom is predicated on five *teaching principles*: first, the setting emphasizes small-group instruction (e.g., Rincover & Koegel, 1977). Class size is seldom greater than six pupils. Second, the teaching approach follows the model of direct instruction (e.g., Becker & Carnine, 1981; Carnine, 1981). That is, instructional management draws on the strength of task analysis (e.g., Becker et al., 1975; Hedbring & Holmes, 1977), precision teaching (Lindsley, 1964), and applied behavior analysis (e.g., Lovaas & Newsom, 1976; Newsom, 1981; Newsom, Carr & Lovaas, 1979; Rincover & Koegel, 1977; Rutter, 1970). Third, Program STEPPE tries to familiarize teachers with and encourage them to use teaching techniques (shaping, fading, prompting, chaining, extinction, repeated practice, data collection) empirically found to be successful with this population (e.g., Koegel et al., 1977, 1982). Fourth, in light of a convincing literature on the quality of instruction (e.g., Anderson, 1981; Arlin, 1984; Carroll, 1963; Rosenshine, 1979, 1983; Wang & Walberg, 1983), the STEPPE lab stresses time and again the importance to pupil performance of prerequisite skills, appropriate materials, task sequencing, cues and prompts, immediate feedback and correction, distributive practice, and contingent reinforcement. Finally, as a classroom the laboratory emphasizes the importance of criterion-level mastery learning (Bloom, 1976, 1981). Accordingly, the end goal of each computer-based learning activity is a pupil-specific predetermined level of proficiency — say, for example, 80 percent correct on a given task. Of course, for each class of six students, the criterion varies depending upon child and learning activity. The point, though, is that the teaching process is far less concerned with efficiency or rate behavior (how quickly a student can complete a task, at perhaps a lower criterion level) and instead stresses the achievement of a minimum level of mastery, irrespective of time frame. By way of summarizing the five teaching principles that Program STEPPE endorses, Bijou (1972) has made a point worth recalling. "When a child fails to make progress," he says, "the course of action is clear: analyze the source

of the problem, present a modified set of conditions, monitor the child's performance under the new conditions, and revise the conditions again if necessary until the child shows progress" (p. 28). The hope is that the instructional rigor practiced in the STEPPE lab will, in time, translate into pupil progress and promote the acquisition of perceptual, fine motor, and functional skills necessary for more independent daily living.

STEPPE-Lab: Safeguards

In light of the behavioral characteristics of the population, several steps have been taken to ensure the safeguard of both the children and the computer equipment. First, the lab classes are grouped functionally, insofar as possible. Classes are structured so that, generally speaking, a group of computer users is working at the same level, although the specific learning activity and task assignments may be varied. To the extent that this functional grouping is achieved, teacher supervision of the entire class is facilitated and potential off-task behaviors can be interrupted before a frustrated child "goes off." Second, in order to further minimize the likelihood of noncompliant, acting-out, or off-task behavior, one computer per child is provided. Thus, the laboratory is engineered so that each child is occupied with some sort of computer-related activity for the duration of the period spent in the lab. Third, the laboratory works only with six youngsters at a time and furthermore, the lab instructor is assisted by a trained paraprofessional during class sessions. This practice ensures that rather close and constant supervision of the computer users, augmentative devices, software, and electrical circuitry can be maintained at all times.

In addition, a number of modifications have been made to the computer equipment to further protect users, teachers, and equipment alike. For example, the two operating buttons on the electronic mouse are covered to eliminate the tendency to press them arbitrarily and thus abort a program. Next, three of the keys (return, control, shift) on the computer keyboard are color-coded so that they can be located easily, thereby reducing off-task intervening behavior. Then, because the on/off computer power switch is located at the rear of the keyboard on the Mindset computer, it too is taped over with heavy cardboard to prevent accidental shutoff. Moreover, a clear adhesive plastic material covers all six computer screens. The purpose of this alteration is to protect the face of the screen during visual tracking and tracing activities that involve hands and fingers coming into contact with the monitor. For the same reason, plastic coverings have been purchased to protect the Apple screens and keyboards as well. In addition, rather large patches containing red cross marks drawn inside a circle are taped near each of the disk drive doors on all computers. These signs designate computer areas that users are taught not to touch. Finally, all electrical wiring (cable, cords, stray wiring) is wrapped securely with reinforced tape and carefully threaded under the tables, out of sight and reach (and mind) of the children. As a result of these precautions, the sole computer-related disruption that has occurred in the lab to date was when this writer dropped (accidentally!) the detached keyboard of the Mindset computer. Such an instance of "acting-out" behavior prompted some colleagues to call for additional restraints designed to bring under environmental control the noncompliant behavior of certain adults!

STEPPE-Lab: CREATING EMPIRICAL SOFTWARE

Good hardware cannot overcome poor software. In light of the continuing lack

of empirical courseware, the plan at STEPPE-Lab was to incorporate several self-developed computer software packages into the project. Hence, efforts were redoubled to refine nine proprietary software programs ("STEPPE-ware") nearing completion in conjunction with another project. Once debugged, the courseware was moved into the computer laboratory for use with the students. At this writing, the STEPPE-ware has undergone more than two years of daily in-class testing with a total of more than forty severely handicapped, autistic students (Hedbring, 1985b). On the strength of this (never-ending) validation and modification process, each STEPPE-ware program integrates at least seven empirically-based features lacking in commercial educational software: (1) All nine of the STEPPE programs offer a smorgasbord of at least six different "positive graphics," each of which runs about ten seconds. In contrast, only one (and the same) "negative graphic" is invoked after an incorrect response. As a result, the student quickly learns to associate incorrect responding with a "sad face" and correct responding with a crescendo of vivid pictures, fast-paced sounds, and lively images. The positive reinforcers are thus varied and graphics-based, the negative graphic constant and "sad," and the supplementary presentation of primary and social rewards is left to the discretion of the teacher. (2) Each curriculum software package clearly separates the instructional component of the module from the entertainment. Hence, there is little chance that the autistic learner will be flooded with unnecessary visual and auditory stimuli within the context of a tightly composed instructional frame. (3) In stark contrast to the commercial packages reviewed to date, each STEPPE-ware program offers a number of instructional aids, including an annual goal, short-term behavioral objective, a logical task analysis, and specific teaching procedures (Becker, Engelmann & Thomas, 1975; Hedbring & Holmes, 1977). Thus, when developing lesson plans or conducting parent meetings or psychological workups, the practitioner has the critical information immediately at hand and on-line at all times. (4) Each package provides a screen of percentage (right and wrong) performance data. Moreover, the data are coded to alert the teacher to which question(s) are answered correctly and which questions result in pupil error. (5) All STEPPE programs have been created by one or more individuals who have advanced training in curriculum design, instructional technology, and abnormal child development. Hence, when flaws are discovered in any aspect of a software program, they can be immediately remedied. (6) Each of the nine STEPPE-ware programs has been written in GW-BASIC to run on machines which use the MS-DOS operating system. Moreover, each program is currently being recoded to run on the Apple IIe as well, using AppleSoft BASIC as the programming language. (7) The STEPPE-ware programs minimize use of speech as the primary communication medium. While speech is certainly not discouraged, the use of keyboard entry, mouse, drawing tablet, and joystick remain the *preferred* communication modes within the laboratory setting.

From a curriculum perspective, the STEPPE-developed programs provide pupils with functional practice in a number of content areas. Some of the more prominent curriculum areas of emphasis include: (a) perceptual skills (visual focusing, visual tracking, visual discrimination), (b) fine motor dexterity (functional use of the computer peripherals), (c) receptive language (understanding words in isolation, understanding contextual language, understanding directions), (d) reading/decoding (sight vocabularly), (e) reading/encoding (recognition and recall of contextual information), and (f) arithmetic (number-

numeral recognition, sequencing, addition and subtraction, and telling time). In addition, most STEPPE-ware exercises stress a regime of daily practice with match-to-sample exercises (words to pictures), visual discrimination (pointing to correct shapes, colors, numbers, words, phrases), long-term visual memory (reciting words and phrases that periodically flash on and off the screen), and reciting "personal survival" information such as correct day of week, correct month and year, full personal name, parents' names, home address and telephone number.

The shortage of IBM- and Apple-compatible educational software *empirically* appropriate for the severely handicapped led to the development and refinement of the STEPPE-ware. However, it should be noted that three software packages written specifically for the Mindset computer were identified and selected early on to serve a valuable, if limited, instructional function. One commercial program ("Designer") allows the child to communicate nonverbally by drawing or writing messages on the computer screen with a mouse. At the same time, the software allows the teacher to construct lesson plans consisting of screens of letters, words, and associations that the child can then use to communicate by means of the mouse and match-to-sample routines. The second package is called "Lumena" and is used in conjunction with a drawing tablet to allow the nonverbal child to communicate more effectively through freehand drawings and sketches. The package offers a tremendous variety of colors, images and a nearly unlimited opportunity for individualized self-expression. The third commercial package was purchased specifically to serve an entertainment function. Upon maintaining on-task attention for a predetermined period of time, the child is given the option of spending five minutes or so manipulating a joystick to chase and intercept plane-like icons that dart around the computer screen. Known as "Vyper," the package offers elaborate color combinations, rich sound mixes, and a pace of action that can be governed by the user. The game has proved to be exciting for some of the higher functioning pupils, along with most of the teachers as well. Together, the three packages, while not instructional in design, have been used nontheless for specific teaching purposes with the severely handicapped, autistic child. Of course we continue to seek appropriate software and at present are reviewing programs from a number of companies (Appendix III). Hopefully, Program STEPPE will be in a position in the near future to recommend a number of courseware packages efforts that satisfy one or more of the seven empirical guidelines set forth above.

STEPPE-Lab: ADMINISTRATION

Shane (1981) describes augmentative systems as those which are "designed to transmit information that typically is expressed through oral speech" (p. 392). As one such communication system, the computer offers a number of advantages. To begin with, it is patient; the computer gets nejther frustrated nor bored. It never raises its voice, never tantrums and it is never late or grouchy. Second, the user can work at a self-determined pace for as long as (s)he desires and the computer will comply with no complaint (or recourse!). Third, the computer is instructionally neutral; it offers no cues that might prompt or otherwise bias user responses. Fourth, the computer appears to be reinforcing. Most of our lab

students use it eagerly, although at times perhaps a bit roughly.

A fifth advantage the computer offers as an augmentative communication option is ease of mastery. To our surprise, eighteen of the more than forty severely handicapped, autistic children learned to use the mouse or joystick in a functional (means-end) manner within thirty minutes of their introduction. Fifteen pupils have learned to use the computer keyboard, although it should be noted that two problems came to light along the way. For those students unable or unwilling to learn letter discrimination, the keyboard is essentially useless. In such cases, letter recognition training procedures are then devised, prescribed and demonstrated for the teacher. A second problem associated with keyboard use is the tendency on the part of three users in particular to press the keys harshly or hold them down too long. In either case, error messages result or the program shuts down, necessitating start-up from the beginning and generating undue instructional delays. A sixth and final major advantage the computer offers is its extended "mean time between failure" rate. Whereas we teachers, aides and administrators tend to fall ill and require sick leave — sometimes at the most inopportune time — the computer is essentially a model of perfect health. If it succeeds in operating without circuitry error for the first three months or so, the computer will run indefinitely without structural failure or electronic fault. To wit, then: the computer is suprisingly "fault tolerant" — of people, function, and abuse.

At the same time, nearly three years of experience in a city-based public school setting has resulted in the evolution of six prerequisites for optimal administration of a computer laboratory. First, teachers and administrators must understand that the computer is an instructional aid rather than a behavior manager. Its primary purpose is to teach, not entertain. Second, it should be understood that the computer is augmentative, not supplantive. The "bookless curriculum" employed in the STEPPE lab is not meant to replace teachers or their curriculum. The STEPPE lab strives only to supplement more traditional approaches to teaching perceptual-motor and everyday functional-use skills. Third, in terms of communication, the computer should be viewed as a system to be used in conjunction with speech. At all times the students are encouraged to talk and to speak meaningfully; the computer simply offers pupils who are nonvocal or nonverbal a viable and practical alternative means for self-expression. Fourth, teachers must learn to treat the computer as a classroom administrative tool rather than a teacher accountability weapon. The computer is not intended to monitor annual goals, weekly teaching objectives, everyday lesson plans, individualized educational programs or other teacher records and files. Instead, the inclusion of such information oncomputer disks is intended to facilitate the storage and retrieval of instructional data during parent meetings, staff discussions, and pupil assessment conferences.

When these four principles of computer-use have been understood and accepted, a fifth prerequisite becomes important. If computers are to serve effectively as an augmentative communication and/or instructional aid, users must be able to manage their own behavior, at least to some degree. To restate what is not altogether apparent at the classroom level, behavior management is a prequisite for, not an annual goal of, computer-aided instruction. Because of the danger posed to equipment and personnel alike, acting-out behavior in the form of temper tantrums, self-abuse, physical aggressiveness and the like results in immediate removal of the noncompliant child from the STEPPE lab for a

temporary period of time. Turning to the sixth and final prerequisite for establishing a computer laboratory on a long-range basis, a measure of fine-motor dexterity is necessary for using the augmentative computer devices functionally. Hence, the lab spends considerable time at the beginning of each school year prescreening each child in order to be certain that the computer keys can be located and depressed appropriately, that the pen or stylus that is attached to the graphics tablet can be held usefully, and that the joystick and mouse can be manipulated successfully. At this point in time, only four students have been unable to benefit from the use of any of the augmentative computer devices on account of insufficiently developed fine motor skills.

STEPPE-Lab: ASPIRATIONS

Program STEPPE has identified five long-term goals the laboratory will be pursuing during the coming years. First, we want to begin to quantify some of our findings, to move away from anecdotal reports and teacher observations toward more experimental analyses. We want to know, for example, which of the augmentative devices is most effective in promoting self-expression with students and under what conditions. We would also like to look more closely at motivation. There is, for example, a body of research that addresses the motivational properties of sensory stimulation (Murphy, 1982; Rincover, 1978; Rincover, Cook, Peoples & Packard, 1979; Rincover, Newsom, Lovaas & Koegel, 1977). Hence, a question arises: Can the computer serve as a secondary reinforcing agent for severely handicapped children? Our initial observations suggest the affirmative. We have found that while autistic children typically encounter problems talking with people, they have considerably less trouble interacting with and communicating through computers (Hedbring 1985b). Our findings are consistent with earlier evidence that autistic children demonstrate greater skills in the visual modality than in the auditory modality (Hermelin & Frith, 1971; Hermelin & O'Connor, 1967, 1970; Lockyer & Rutter, 1970). Since the computer represents a predominantly visual medium and since many autistic children tend to be visual learners, a program of contingent computer use should prove empirically to be highly reinforcing. Moreover, taking a cue from the work of Goetz, Gee and Sailor (1985), we want to look also at the strategy of using "behavior chain interruption" to teach communication skills. They argue that embedding specific instructional tasks within a chain of existing behavior seems to increase on-task motivation. Such a motivational tactic lends itself well to study by use of computers. On the other hand, we plan to investigate where or not its sensory properties will enable the computer to also serve as an extinction device for decreasing inappropriate behaviors as well. If formal research determines the computer to be a reinforcing agent, the use of joysticks, drawing tablets, and graphics-based instructional software could become powerful ally in our attempts to minimize self-abuse and noncompliant behavior, in addition to its function as an augmentative communication and instructional device.

Another area fertile for formal investigation is also related to the sensory properties of the computer. A number of researchers (e.g., Carr, 1985; Carr & Durand, 1985) have found a relationship between the communication competence of severely handicapped students and their behavior problems. That is, as

children improve in their ability to interact with others, their behavior problems begin to decrease. One logical question within this context is whether or not there is a similar relationship between a decrease in behavior problems and mastery of a keyboard, joystick, mouse, or drawing tablet. We hope to shed more light on that issue in the coming months. A fourth question STEPPE-Lab is pursuing concerns an attentional deficit known as overselective responding, a learning handicap that often results in high rates of discrimination learning error (Bickel, Stella & Etzel, 1984; Cook, Anderson & Rincoyer, 1982; Lovaas, Koegel & Schreibman, 1979; Schreibman & Lovaas, 1973; Schreibman, Koegel & Craig, 1977). Simply stated, can the computer reduce the level of overselectivity in children who exhibit the handicap and who are then exposed to extensive computer-assisted instruction? Because of the nature of that handicap in particular and in light of promising strategies to ameliorate it, the use of computer-based strategies for remediating overselectivity warrants formal investigation.

A fifth and final goal that STEPPE-Lab has targetted for future pursuit is the issue of generalization. Since the skills learned in the STEPPE lab may wash out in other settings, generalization must be taught rather than inferred (Stokes & Baer, 1977). Accordingly, would it be instructionally profitable, for example, to consider a twenty-four hour communication training approach, perhaps, involving parents and group homes (Kopchick & Lloyd, 1976)? Even with the arrival of high-powered, lightweight, and highly portable "laptop" computers (*Business Computer Systems*, 1985), would this "longitudinal" approach be practical (cf. Nietupski, Scheutz & Ockwood, 1980)? Furthermore, how would a decision to move beyond episodic laboratory sessions toward longer-term total communication programs impact the already nettlesome problem of providing effective teacher and parent training over the long term (e.g., Koegel, Russo & Rincover, 1977; Koegel, Russo, Rincover & Schreibman, 1982)? Finally, would the generalized use of the computer as a augmentative communicative device promote the integration of these students into more regular classrooms (e.g., Dunlap, Koegel & Egel, 1979; Handleman, 1981; Hanline & Murray, 1984; Koegel & Rincover, 1974; Panyan, 1984; Rincover & Koegel, 1977; Russo & Koegel, 1977)? These and other questions eagerly await serious investigation if practitioners and researchers are to better understand the proper use of microcomputers as an instructional and communication technology with severely handicapped, nonverbal students.

There is much work to be done, many questions to be answered over the next several years. On our immediate agenda for STEPPE-Lab are three pressing concerns that Program STEPPE has already begun to address. First is the question of just how much pupil-performance data should be generated by computer software. Our decision to date is that trial-by-trial data can be useful, that knowing which question has been answered correctly or not and which problems on a discrimination task were right or wrong may reveal tendencies and trends. Hence, the STEPPE lab is working to refine the automatic record-keeping component of our programs. A second concern relates to the applied research that has found peer modeling and peer-training to benefit pupil performance, including autistic learners (e.g., Apolloni, Cooke & Cooke, 1976; Egel, Richman & Koegel, 1981; cf. Shafer, Egel & Neefe, 1984). Will the use of peer models and trainers affect the level of pupil performance and duration of on-task attention? The STEPPE lab has successfully trained two of our more computer-versatile

students to monitor their four classmates in the use of three STEPPE programs. In one case in particular, the autistic student learned to act as a tutor, guiding his peers with gestures and a surprising amount of verbal expression, with practically no need of teacher intervention whatsoever. Through the use of videotaped documentation, it has become clear to teachers and administrators alike that peer tutoring and peer modeling hold great promise for teaching severely handicapped youngsters to use selected computer hardware and software.

The third area of concern that STEPPE-Lab is presently pursuing is more managerial in nature. If computers may allow kids to learn, people can bring it all to a full stop. Directing a computer laboratory in a unionized public school in a mammoth educational bureaucracy carries with it a surfeit of excess baggage, both administrative and political. That baggage, intentionally or otherwise, directly affects the way children learn. At the district level, administrators who are far removed from the classroom setting tend to become threatened when confronted by innovation, particularly if a new program demonstrates early success. Perhaps most intimidated of all are career personnel who perceive a need to defend their turf at whatever cost. Rather quickly, then, such individuals can dry up seed money in short order and erect a veritable fortress of barriers to stifle change at a moment's notice. At the building level, a principal or other "street-level" administrator may play with a computer, grow to like the arcade-games or paperwork-easing programs, take a two-week Board-of-Education computer course and return to the building quite the expert. Far too often, their return is accompanied by a battery of ideas they just know will solve most or all of the problems. The real problem, to be sure, is that their "suggestions" generally have to be honored. If their suggestions then fail, the subordinate is of course left holding the proverbial bag! At the classroom level, a teacher, unit head or master teacher who, for whatever reason, wants a "piece of the action," may ask (indeed, demand) that one of the lab computers (a) be used with his or her children more frequently ("practice makes perfect"), (b) be used also in his or her homeroom ("to promote generalization"), (c) be used to streamline administrative tasks ("surely you can give up one of the computers for just three hours a week!"), or (d) be made available during teacher "prep periods" ("you want me to learn also, don't you"). Whatever the reasons and irrespective of their legitimacy, a great deal of precious instructional time and effort can get siphoned off by these and other examples of misplaced precision. Indeed, for some professionals, change just does not come easily. The result is that, at times, all that excess baggage gets to be a bit weighty!

Accordingly, the early success of the STEPPE lab prompted studied attention to how best to secure political allegiances and marshall administrative support, particularly at the building and district level. Unlike university-based labs or government funded research centers, demonstration projects located in public schools require unflagging support on the part of power-brokers strategically positioned outside the research arena. We have thus attempted to smooth the administrative and political paths in six rather specific ways. First, we invite interested parties important to our cause to visit our laboratory, observe our work and then discuss whatever concerns they may have. Second, we make videotapes of students we are allowed to film. The purpose of the tapes is to demonstrate that (a) nearly all students are able to use the computer and its augmentative devices in some meaningful fashion, (b) the programs Program STEPPE has developed train skills important to helping the children attain levels of greater functional

independence, and (c) at least some of the children can help their classmates run the hardware and software correctly, without teacher intervention. Those videotapes are then made available to selected opinion leaders, supervisors, and others in a position to give our laboratory an endorsement or boost. Third, the author conducts teacher "helpshops" in which the information and knowledge acquired in the STEPPE lab is disseminated to other practitioners. Teachers from other schools in the vicinity who also work with the same population are invited to participate in the skills development sessions as well. Fourth, in order to share our findings with a broader audience, this writer makes presentations before college classes, community groups, and at local, regional and national conferences and conventions. At many of these functions, a selected administrator important to the support of the lab is invited to participate as a co-speaker. Fifth, STEPPE-Lab has established a software library of computer courseware, research studies, and useful readings from the literature in a number of areas relevant to computers, special education, abnormal psychology, and the handicapped. Interested persons are encouraged to browse and borrow materials as long as the software packages are not illegally copied. Finally, the laboratory frequently submits nontechnical articles to a newly created citywide publication entitled, *Input/Output*. This quarterly journal seeks to share information throughout the five city boroughs on the progress, problems, pitfalls, and pratfalls experienced by public schools that maintain computer centers for special education students. Bolstered by these and other ancillary activities, Program STEPPE hopes to share its research outcomes with an ever-widening audience as well as to sustain the support and good will of those in a position to offer the laboratory a helping hand.

TEMPORARY "END-OF-FILE"

Cronbach and Snow (1977) have urged that "(school personnel) be concerned not with running a fair competition but with running a talent-development operation that will bring everyone somewhere near his or her highest level of contribution" (p. 8). Such a challenge requires sound instructional research, a readiness on the part of administrators to innovate, and a desire on the part of teachers to experiment. The STEPPE laboratory is one such experiment, one attempt to demonstrate that microcomputer technology can serve the handicapped as an augmentative communication and instructional aid. As lightweight, high powered, low-cost laptop computers come of age, the use of keyboards, joysticks, mice, and drawing tablets will become increasingly practical. Indeed, only a lack of empirically valid software upsets the balance. Hopefully, then, as the technology continues to mature, the computer may indeed soon do for those unable to talk what the wheelchair has accomplished for those unable to walk. If so, then as Dewey put it some fifty years ago, the computer might, just might, "Let Each Become All (S)he is Capable of Being."

20

ACKNOWLEDGEMENT

The author would like to thank school administrator Mr. Robert Levine, computer programmer Ms. Elizabeth Muesch, and editor Dr. Carl Parsons for their valuable input during the preparation of this article.

Address all correspondence to Dr. Charles Hedbring, Program STEPPE, Suite 1712 Master Apartments, 310 Riverside Drive, New York, 10025, USA. (212) 866 6694.

REFERENCES

Anderson, L.W. (1981). Instruction and time-on-task: A review. *Journal of Curriculum Studies, 13,* 289-303.

Apolloni, T., Cooke, S.A. & Cooke, T.P. (1976). Establishing a normal peer as a behavioral model for developmentally delayed toddlers. *Perceptual and Motor Skills, 43,* 1155-1165.

Arlin, M. (1984). Time, equality, and mastery learning. *Review of Educational Research, 54,* 65-86.

Axelrod, C.W. (1985, June). The new economics of computers. *Infosystems,* pp. 66-68.

Ayllon, T. & Azrin, N.H. (1968). Reinforcer sampling: A technique for increasing the behavior of mental patients. *Journal of Applied Behavior Analysis, 1,* 13-20.

Bates, P. (1984, March). New developments in handicapped access. *Creative Computing,* pp. 124-126.

Becker, W.C. & Carnine, D.W. (1981). Direct instruction: A behavior theory model for comprehensive educational intervention with the disadvantaged. In S.W. Bijou & R. Ruiz (Eds.), *Behavior modification: Contributions to education* (pp. 145-210). Hillsdale, New Jersey: Lawrence Erlbaum.

Becker, W.C., Engelmann, S. & Thomas, D.R. (1975). *Teaching 2: Cognitive learning and instruction.* Chicago: Science Research Associates.

Bickel, W.K., Stella, M.E. & Etzel, B.C. (1984). A reevaluation of stimulus overselectivity: Restricted stimulus control or stimulus control hierarchies. *Journal of Autism and Developmental Disorders, 14,* 137-157.

Bijou, S.W. (1972). The technology of teaching young handicapped children. In S.W. Bijou & E. Ribes-Inesta (Eds.), *Behavior modification: Issues and extensions* (pp. 27-42). New York: Academic Press.

Blaschke, C.L. (1985). Technology trends in special education. *T.H.E. Journal, 12*(6), 73-77.

Bliss, C. (1965). *Semantography.* Sydney, Australia: Semantography Publications.

Bloom, B. (1976). Quality instruction. In B. Bloom, *Human characteristics and school learning* (pp. 108-138). New York: McGraw-Hill.

Bloom, B. (1981). The new direction in educational research; Alterable variables. *Phi Delta Kappan, 61,* 382-385.

Boraiko, A.A. (1982, October). The chip. *National Geographic,* pp. 421-476.

Burns, E. (1985, July). The great arcade con. *Popular computing,* p. 140.

Butler, G.S. & Rabinowitz, F.M. (1951). An investigation of factors contributing to the apparent overselective responding of mentally retarded children. *Child Development, 52,* 430-442.

Business Computer systems (1985, August, pp. 74-84). Computers to go.

Business Week (1984, October 29, pp. 121, 124, 126). Educational software: Why it's a hard sell.

Business Week (1985, June 24, pp. 74-80). The computer slump.

Carnine, D.W. (1981). High and low implementation of direct instruction teaching techniques. *Education and Treatment of Children, 4,* 43-51.

Carr, E.G. (1979). Teaching autistic children to use sign language: Some research issues. *Journal of Autism and Developmental Disorders, 9,* 345-359.

Carr, E.G. (1982). Sign language. In R.L. Koegel, A. Rincover & A.L. Egel (Eds.), *Educating and understanding autistic children* (pp. 142-157). San Diego: College-Hill Press.

Carr, E.G. (1985). Behavioral approaches to language and communication. In E. Schopler & G. Mesibov (Eds.), *Current issues in autism: Volume 3. Communication problems in autism* (pp. 219-254). New York: Academic Press.

Carr, E.G. & Durand, V.M. (1985). Reducing behavior problems through functional communication training. *Journal of Applied Behavior Analysis, 18,* 111-126.

Carr, E.G., Pinkoff, J.A., Kologinsky, E. & Eddy, M. (1978). Acquisition of sign language by autistic children. I: Expressive labelling. *Journal of Applied Behavior analysis, 11,* 489-501.

Koegel, R.L. & Egel, A.L. (1979). Motivating autistic children. *Journal of Abnormal Psychology, 8*, 418-425.

Koegel, R.L., Egel, A.L. & Dunlap, G. (1980). Learning characteristics of autistic children. In W. Sailor, B. Wilcox & L. Brown (Eds.), *Methods of instruction for severely handicapped students* (pp. 259-301). Baltimore: Paul Brookes.

Koegel, R.L. & Rincover, A. (1974). Classroom treatment of psychotic children: I. Learning in a large group. *Journal of Applied Behavior Analysis, 7*, 45-59.

Koegel, R.L. & Russo, D.C. & Rincover, A. (1977). Assessing and training teachers in the generalized use of behavior modification with autistic children. *Journal of Applied Behavior Analysis, 10*, 197-205.

Koegel, R.L. & Russo, D.C., Rincover, A. & Schreibman, L. (1982). Assessing and training teachers. In R.L. Koegel, A. Rincover & A.L. Egel (Eds.), *Educating and understanding autistic children* (pp. 178-202). San Diego: College Hill Press.

Kohl, F.L. (1981). Effects of motoric requirements on the acquisition of manual sign responses by severely handicapped students. *American Journal of Mental Deficiency, 85*, 396-403.

Kopchick, G.A. & L.L. Lloyd (1976). Total communication programming for the severely language impaired: A 24-hour approach. In L.L. Lloyd (Ed.), *Communication assessment and intervention strategies* (pp. 501-521). Baltimore: University Park Press.

Krupski, A. (1980). Attention processes: Research, theory, and implications for special education. In B.K. Keogh (Ed.), *Advances in special education* (pp. 101-140). Greenwich, CT: JAI Press.

Lindsley, O.R. (1964). Direct measurement and prosthesis of retarded behavior. *Journal of Education, 33*, 624-633.

Lockyer, L. & Rutter, M. (1970). A five to fifteen year followup of infantile psychosis. IV: Patterns of cognitive ability. *British Journal of Social and Clinical Psychology, 9*, 152-163.

Lovaas, O.I. (1977). *The autistic child: Language development through behavior modification*. New York: Irvington Press.

Lovaas, O.I. (1981). *Teaching developmentally disabled children*. Baltimore: University Park Press.

Lovaas, O.I. & Koegel, R.L. (1973). Behavior therapy with autistic children. In C.E. Thoresen (Ed.), *Seventy-second yearbook of the National Society for the Study of Education. Part II: Behavior modification in education* (pp. 230-258). Chicago: University of Chicago Press.

Lovaas, O.I., Koegel, R.L. & Schreibman, L. (1979). Stimulus overselectivity in autism: A review of research. *Psychological Bulletin, 86*, 1236-1254.

Lovaas, O.I. & Newsom, C.D. (1976). Behavior modification with psychotic children. In H. Leitenberg (Ed.), *Handbook of behavior modification and behavior therapy* (pp. 303-361). Englewood Cliffs, NJ: Prentice-Hall.

Lovaas, O.I., Young, D.B. & Newsom, C.D. (1978). Childhood psychosis: Behavioral treatment. In B.B. Wolman, J. Egan & A.O. Ross (Eds.), *Handbook of treatment of mental disorders of childhood and adolescence* (pp. 385-420). Englewood Cliffs, NJ: Prentice-Hall.

Meador, D.M. (1984). Effects of color on visual discrimination of geometric symbols by severely and profoundly mentally retarded individuals. *American Journal of Mental Deficiency, 89*, 275-286.

Meador, D.M. Rumbaugh, D.M., Tribble, M. & Thompson, S. (1984). Facilitating visual discrimination learning of moderately and severely mentally retarded children through illumination of stimuli. *American Journal of Mental Deficiency, 89*, 313-316.

Moores, D.F. (1974). Alternative communication modes: Visual motor systems. In R.L. Schiefelbusch (Ed.), *Nonspeech language and communication: Analysis and intervention*. Baltimore: University Park Press.

Mulligan, M., Lacy, L. & Guess, D. (1982). Effects of massed, distributed, and spaced trial sequencing on severely handicapped students' performance. *JASH, 7*, 48-61.

Murphy, G. (1982). Sensory reinforcement in the mentally handicapped and autistic child: A review. *Journal of Autism and Developmental Disorders, 12*, 265-278.

Newsom, C.D. (1981). School. In O.I. Lovaas, *Teaching developmentally disabled children* (pp. 223-233). Baltimore: University Park Press.

Newsom, C.D., Carr, E.G. & Lovaas, O.I. (1979). The experimental analysis and modification of autistic behavior. In R.S. Davidson (Ed.), *Modification of pathological behavior* (pp. 109-187). New York: Gardner Press.

Newsom, C.D. & Rincover, A. (1981). Autism. In E.J. Mash & L.G. Terdal (Eds.), *Behavioral assessment of childhood disorders* (pp. 397-439). New York: Guildford Press.

Nietupski, J., Scheutz, G. & Ockwood, L. (1980). The delivery of communication therapy services to severely handicapped students: A plan for change. *JASH, 5*(1), 13-23.

Ornitz, E.M. & Ritvo, E.R. (1976). The syndrome of autism: A critical review. *American Journal of Psychiatry, 133*, 609-621.

Panyan, M.V. (1984). Computer technology for autistic students. *Journal of Autism and Developmental Disorders, 14*, 375-382.

Quigley, S.P. (1969). The influence of fingerspelling on the development of language, communication and educational achievement in deaf children. Institute for Research on Exceptional Children, University of Illinois, Urbana – Champaign.

Ricks, D.M. & Wing, L. (1976). Language, communication and the use of symbols. In L. Wing (Ed.), *Early childhood autism* (pp. 93-134). Oxford: Pergamon Press.

Rincover, A. (1978). Sensory extinction: A procedure for eliminating self-stimulatory behavior in developmentally disabled children. *Journal of Abnormal Child Psychology, 6*, 299-310.

Rincover, A., Cook, R., Peoples, A. & Packard, D. (1979). Sensory extinction and sensory reinforcement principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis, 12*, 221-233.

Rincover, A. & Koegel, R.L. (1977). Research on the education of autistic children: Current status and future directions. In B.B. Lahey & A.E. Kazdin (Eds.), *Advances in clinical child psychology* (Vol. 1 pp. 329-359). New York: Plenum Press.

Rincover, A., Koegel, R.L. & Russo, D. (1978). Some recent behavioral research on the education of autistic children. *Education and Treatment of Children, 1* (4), 31-45.

Rincover, A., Newsom, C.D., Lovaas, O.I. & Koegel, R.L. (1977). Some motivational properties of sensory reinforcement in psychotic children. *Journal of Experimental Child Psychology, 24*, 312-323.

Rosenshine, B. (1979). Content, time, and direct instruction. In P.L. Peterson & H.J. Walberg (Eds.), *Research on teaching: Concepts, findings, and implications* (pp. 28-56). Berkeley, CA: McCutchan.

Rosenshine, B. (1983). Teaching functions in instructional programs. *The Elementary School Journal, 83*, 335-351.

Ross, A.O. (1976). *Psychological aspects of learning disabilities and reading disorders*. New York: McGraw-Hill.

Rushakoff, G.E. & Lombardino, L.J. (1983). Comprehensive microcomputer applications for severely physically handicapped children. *Teaching Exceptional Children, 16*(1), 18-22.

Russo, D.C. & Koegel, R.L. (1977). A method for integrating an autistic child into a normal public-school classroom. *Journal of Applied Behavior Analysis, 10*, 579-590.

Russo, D.C. & Newsom, C.D. (1982). Psychotic disorders of childhood. In J.R. Lachenmeyer & M.S. Gibbs (Eds.), *Psychopathology in childhood* (pp. 120-154). New York: Gardner Press.

Rutter, M. (1966). Prognosis: Psychotic children in adolescence and early adult life. In J.K. Wing (Ed.), *Early childhood autism* (pp. 83-99). London: Pergamon Press.

Rutter, M. (1968). Concepts of autism: A review of the research. *Journal of child Psychology and Psychiatry, 9*, 1-25.

Rutter, M. (1970). Autism: Educational issues. *Special Education, 59*(3), 6-10.

Rutter, M. (1978). Diagnosis and definition. In M. Rutter & E. Schopler (Eds.), *Autism: A reappraisal of concepts and treatment* (pp. 1-25). New York: Plenum Press. (a).

Rutter, M. (1978). Language disorder and infantile autism. In M. Rutter & E. Schopler (Eds.), *Autism: A reappraisal of concepts and treatment* (pp. 85-104). New York: Plenum Press. (b)

Sailor, W., Guess, D., Goetz, L., Schuler, A. Utley, B. & Baldwin, M. (1980). Language and severely handicapped persons. In W. Sailor, B. Wilcox & L. Brown (Eds), *Methods of instruction for severely handicapped students* (pp. 71-105). Baltimore: Paul Brookes.

Schover, L.R. & Newsom, C.D. (1976). Overselectivity, developmental level, and overtraining in autistic and normal children. *Journal of Abnormal Child Psychology, 4*, 289-298.

Schreibman, L. & Koegel, R.L. (1982). Multiple-cue responding in autistic children. In J. Steffen & P. Karoly (Eds.), *Advances in child behavioral analysis and therapy, Vol. II: Autism and severe psychopathology* (pp. 81-99). Lexington, MA: Heath and Co.

Carrier, J.K. (1974). Application of functional analysis and non-speech response mode to teach language. *American Speech and Hearing Association* [Monograph], *18*, 47-95.

Carrier, J.K. (1976). Application of a nonspeech language system with the severely language handicapped. In L.L. Lloyd (Ed.), *Communication assessment and intervention strategies* (pp. 523-547). Baltimore: University Park Press.

Carrier, J.K. & Peak, T. (1975). *Non-speech language initiation program*. Lawrence, Kansas; H & H Enterprises.

Carroll, J.B. (1963). A model of school learning. *Teachers College Record, 64*, 723-733.

Chess, S. (1971). Autism in children with congenital rubella. *Journal of Autism and Childhood Schizophrenia, 1*, 33-47.

Colby, K. (1973). The rationale for computer-based treatment of language difficulties in non-speaking autistic children. *Journal of Autism and Childhood Schizophrenia, 3*, 254-260.

Cook, A.R., Anderson, N. & Rincover, A. (1982). Stimulus overselectivity and stimulus control: Problems and strategies. In R.L. Koegel, A. Rincover, & A.L. Egel (Eds.), *Educating and understanding autistic children* (pp. 90-105). San Diego: College Hill Press.

Cronbach, L.J. & Snow, R.E. (1977). *Aptitudes and instructional methods*. New York: Irvington.

Curcio, F. (1978). Sensorimotor functioning and communication in mute autistic children. *Journal of Autism and Childhood Schizophrenia, 8*, 281-292.

Davis, M. (1983, July). The chip at 35. *Personal Computing*, pp. 127-131.

Deich, R.F. & Hodges, P.M. (1982). Teaching nonvocal communication to nonverbal retarded children. *Behavior Modification, 6*, 200-228.

Duker, P.C. & Michielsen, H. (1983). Cross-setting generalization of manual signs to verbal instructions with severely retarded children. *Applied Research in Mental Retardation, 4*, 29-40.

Duker, P.C. & Morsink, H. (1984). Acquisition and cross-setting generalization of manual signs with severely retarded individuals. *Journal of Applied Behavior Analysis, 17*, 93-103.

Dunlap, G. & Egel, A.L. (1982). Motivational techniques. In R.L. Koegel, A. Rincover & A.L. Egel (Eds.), *Educating and understanding autistic children* (pp. 106-126). San Diego: College Hill Press.

Dunlap, G. & Koegel, R.L. (1980). Programming the delivery of instruction for autistic children. In B. Wilcox & A. Thompson (Eds.), *Critical issues in educating autistic children and youth* (pp. 89-117). Washington, DC: Office of Special Education.

Dunlap, G., Koegel, R.L. & Egel, A.L. (1979). Autistic children in school. *Exceptional Children, 45*, 552-558.

Egel, A.L. (1980). The effects of constant vs. varied reinforcer presentation on responding by autistic children. *Journal of Experimental Child Psychology, 30*, 455-463.

Egel, A.L. (1981). Reinforcer variation: Implications for motivating developmentally disabled children. *Journal of Applied Behavior Analysis, 14*, 345-350.

Egel, A.L., Richman, G.S. & Koegel, R.L. (1981). Normal peer models and autistic children's learning. *Journal of Applied Behavior Analysis, 14*, 3-12.

Etzel, B.C. & LeBlanc, J.M. (1979). The simplest treatment alternative: the law of parsimony applied to choosing appropriate instructional control and errorless-learning procedures for the difficult-to-teach child. *Journal of Autism and Developmental Disorders, 9*, 361-382.

Falvey, M., Brown, L., Lyon, S., Baumgart, D. & Schroeder, J. (1980). Strategies for using cues and correction procedures. In W. Sailor, B. Wilcox, & L. Brown (Eds.), *Methods of instruction for severely handicapped students* (pp. 109-133). Baltimore: Paul Brooks.

Fay, W.H. (1969). On the basis of autistic echolalia. *Journal of Communication Disorders, 2*, 31-41.

Ferraro, M. & Harris, S.L. (1981). The limits and motivating potential of sensory stimuli as reinforcers for autistic children. *Journal of Applied Behavior Analysis, 14*, 339-343.

Frith, U. & Hermelin, B. (1969). The role of visual and motor cues for normal, subnormal, and autistic children. *Journal of Child Psychology and Psychiatry, 10*, 153-163.

Gierstein, R.M. (1980). In search of the cognitive deficit in autism: Beyond the stimulus overselectivity model. *Journal of Special Education, 14*, 49-65.

Gibson, E.J. (1969). *Principles of perceptual learning and development*. New York: Appleton-Century-Crofts.

Goetz, L., Gee, K. & Sailor, W. (1985). Using a behavior chain interruption strategy to teach communication skills to students with severe disabilities. *JASH, 10,* 21-30.

Goetz, L., Schuler, A. & Sailor, W. (1979). Teaching functional speech to the severely handicapped: Current issues. *Journal of Autism and Developmental Disorders, 9,* 325-343.

Grimes, L. (1981). Error analysis and error correction procedures. *Teaching Exceptional Children, 14*(1), 12-17.

Guess, D. (1980). Methods in communication instruction for severely handicapped persons. In W. Sailor, B. Wilcox & L. Brown (Eds.), *Methods of instruction for severely handicapped students* (pp. 195-225). Baltimore: Paul Brookes.

Guess, D., Sailor, W. & Baer, D. (1976). *Functional speech and language training for the severely handicapped.* Lawrence, Kansas: H & H Enterprises.

Gutierrez-Griep, R. (1984). Student preference of sensory reinforcers. *Education and Training of the Mentally Retarded, 19,* 108-113.

Hagen, D. (1984). *Microcomputer resource book for special education.* Reston Publishing Council for Exceptional Children.

Hallahan, D.P. & Reeve, R.E. (1980). Selective attention and distractibility. In B.K. Keogh (Ed.), *Advances in special education* (pp. 141-181). Greenwich, CT: JAI Press.

Handleman, J.S. (1981). A model for self-contained classes for autistic-type youngsters. *Education and Treatment of Children, 4,* 61-70.

Hanline, M.F. & Murray, C. (1984). Integrating severely handicapped children into regular public schools. *Phi Delta Kappan, 64,* 273-276.

Harris, D. & Vanderheiden, G.C. (1980). Augmentative communication techniques. In R.L. Schiefelbusch (Ed.), *Nonspeech language and communication: Analysis and intervention* (pp. 259-301). Baltimore: University Park Press.

Harris, S. (1975). Teaching language to nonverbal children — with emphasis on problems of generalization. *Psychological Bulletin, 82,* 565-580.

Hedbring, C. (1981). *A comparison of two instructional procedures for remediating attentional deficits of autistic school-age children overselective in the visual modality* (Final report No. G008001901). Washington, DC: United States Office of Education/Bureau of Education for the Handicapped. (Available from the author.)

Hedbring, C. (1985). *Computers and autistic learners: An empirical rationale.* Manuscript submitted for publication. (a)

Hedbring, C. (1985). *Developing computer courseware for the severely handicapped: Emerging guidelines.* Manuscript submitted for publication. (b)

Hedbring, C. & Holmes, C. (1977). Getting it together with PL 94-142: The IEP in the classroom. *Education and Training of the Mentally Retarded, 12,* 212-224.

Hedbring, C. & Newsom, C. (1985). Visual overselectivity: A comparison of two instructional remediation procedures with autistic children. *Journal of Autism and Developmental Disorders, 15,* 9-22.

Hermelin, B. & Frith, U. (1971). Psychological studies of childhood autism: Can autistic children make sense of what they see and hear? *Journal of Special Education, 5,* 107-117.

Hermelin, B. & O'Connor, N. (1967). Perceptual and motor discrimination in psychotic and normal children. *Journal of Genetic Psychology, 110,* 117-125.

Hermelin, B. & O'Connor, N. (1970). *Psychological experiments with autistic children.* New York: Pergamon Press.

InfoWorld (July 29, 1985, pp. 48-49). Scanning pages for less scratch.

Jones, V. & Prior, M. (1985). Motor imitation abilities and neurological signs in autistic children. *Journal of Autism and Developmental Disorders, 15,* 37-46.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 181-197.

Kanner, L. (1944). Early infantile autism. *Journal of Pediatrics, 25,* 211-217.

Kent, L. (1974). *Language acquisition program for the severely retarded.* Champaign, Illinois: Research Press.

Schreibman, L. & Lovaas, O.I. (1973). Overselective response to social stimuli by autistic children. *Journal of Abnormal Child Psychology, 1*, 152-168.

Schreibman, L., Koegel, R.L. & Craig, M.S. (1977). Reducing stimulus overselectivity in autistic children. *Journal of Abnormal Child Psychology, 5*, 425-436.

Scott, K.G. (1966). Engineering attention: Some rules for the classroom. *Education and Training of the Mentally Retarded, 1*, 125-129.

Shane, H.C. (1981). Decision-making in early augmentative communication use. In R.L. Schiefelbusch & D.D. Bricker (Eds.), *Early language: Acquisition and intervention* (pp. 389-425). Baltimore: University Park Press.

Shafer, M.S., Egel, A.L. & Neef, N.A. (1984). Training mildly handicapped peers to facilitate changes in the social interaction skills of autistic children. *Journal of Applied Behavior Analysis, 17*, 461-476.

Stevenson, H.W. (1972). *Children's learning*. Englewood Cliffs, NJ: Prentice-Hall.

Stokes, T.F. & Baer, D.M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349-367.

Taber, F.M. (1981). The microcomputer — Its applicability to special education. *Focus on Exceptional Children, 14*(2), 1-14.

Thomas, M.A. (Ed.) (1982). Microcomputers' place in special education. *Exceptional Children, 49*(2).

Trabasso, T. (1968, October). Pay attention. *Psychology Today*, pp. 30-36.

Vanderheiden, G.C. & Harris-Vanderheiden, D. (1976). Communication techniques and aids for the nonvocal severely handicapped. In L.L. Lloyd (Ed.), *Communication assessment and intervention strategies* (pp. 607-652). Baltimore: University Park Press.

Varni, J.W., Lovaas, O.I., Koegel, R.L. & Everett, N.L. (1979). An analysis of observational learning in autistic and normal children. *Journal of Abnormal Child Psychology, 7*, 31-48.

Wang, M.C. & Walberg, H.J. (1983). Adaptive instruction and classroom time. *American Educational Research Journal, 20*, 601-626.

Williams, J.A., Koegel, R.L. & Egel, A.L. (1981). Response-reinforcer relationships and improved learning in autistic children. *Journal of Applied Behavior Analysis, 14*, 53-60.

Wing, L. (1976). *Early childhood autism: Clinical, educational, and social aspects* (2nd ed.). New York: Pergamon Press.

Zeaman, D. & House, B.J. (1979). The role of attention in retardate discrimination learning. In N.R. Ellis (Ed.), *Handbook of mental deficiency* (2nd ed., pp. 159-223). New York: McGraw-Hill.

APPENDIX I
PRODUCTS AND MATERIALS

Arts Computer Products, Co.
PC Orator
145 Tremont Street, Suite 407
Boston, MA 02111 USA

Corporation for Public Broadcasting
Report entitled, "School Utilization Study:
Availability, Use, and Support of Instructional Media"
Available for $5 U.S., Office of Corporate Communications
1111 16th Street, N.W.
Washington, DC 20036 USA

Keytronic Corporation, Co.
Adaptive Keyboards
Spokane, WA 99216 USA

Kurzweil Computer Products, Co.
Kurzweil Reading Machine
33 Cambridge Parkway
Cambridge, MA 02142 USA

Linc Associates, Co.
The Special/Ware Directory:
A Guide to Software Sources for Special Education
46 Arden Road
Columbus, Ohio 43214 USA

Micro Video, Co.
Video Voice Speech Training System
314 N. 1st Street
P.O. Box 7357
Ann Arbor, MI 48107 USA

Oberon International Omni-Reader
MacArthur Plaza, Suite 630
5525 MacArthur Blv.
Irving Texas 75062 USA

Prentke Romich Company
Special Keyguards
8769 Township Road 513
Shreve Ohio, 44676 USA

Sentient Systems Tech, Co.
EyeTyper
5001 Baum Blvd.
Pittsburgh, PA 15213 USA

Telesensory Systems, Co.
VersaBraille
P.O. Box 7455
Mountain View, CA 94039 USA

Visualtek
Large Print Displays
1610 26th Street
Santa Monica, CA 90404 USA

Votrax Company
Type-'N-Talk
1394 Rankin road
Troy, Michigan 48083 USA

Zygo Industries, Co.
Augmentative Keyboards
P.O. Box 1008
Portland Oregon 97207 USA

APPENDIX II
SELECTED COMPUTER PERIODICALS
SUBSCRIPTION INFORMATION

Byte, P.O. Box 590, Martinsville, NJ 08836 USA
Computer disability News, 2023 W. Ogden Ave., Chicago, IL 60612 USA
Creative Computing, P.O. Box 789-M, Morristown, NJ 07960 USA
Electronic Learning, 902 Sylvan Ave., Englewood Cliffs, NJ 07632 USA
InfoWorld, P.O. Box 1018, Southeastern, PA 19398 USA
Input/Output, c/o Suite 1712, 310 Riverside Dr., NY, NY 10025 USA
Mini-Micro Systems, 270 St. Paul Street, Denver, CO 80206 USA
Personal Computing, P.O. Box 2941, Boulder, CO 80321 USA
Popular Computing, P.O. Box 307, Martinsville, NJ 08836 USA

APPENDIX III
SELECTED SOFTWARE COMPANIES

Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014 USA

Broderbund Software
17 Paul Drive
San Rafael, CA 94903 USA

CBS Software
One Fawcett Place
Greenwich, CT 06836 USA

Electronic Arts
2755 Campus Drive
San Mateo, CA 94403 USA

Hayden Software
600 Suffolk Street
Lowell, MA 01853 USA

IBM Corp.
Personally Developed Software
P.O. Box 328
Wallingford, CT 06494 USA

Program STEPPE
Suite 1712 Master Apts.
310 Riverside Drive
New York, NY 10025 USA

Scarborough Systems, Inc.
25 North Broadway
Tarrytown, NY 10591 USA

Spinnaker Software
One Kendall Square
Cambridge, NA 02139 USA

Springboard Software
7807 Creekridge Circle
Minneapolis, MN 55435 USA

The Learning Company
545 Middlefield Road
Menlo Park, CA 94025 USA